SECTION - VI

PARTICULAR TECHNICAL SPECIFICATIONS
Overhead Lines

TABLE OF CONTENTS

5 PARTICULAR TECHNICAL SPECIFICATIONS – 66, 33 AND 11 KV OVERHEAD LINES

5.1.1 Nature and Extent of Work

The work covered by this Specification forms part of the KPLC's Distribution and Reinforcement Project and is for design, survey, supply, installation and commissioning of new 66, 33 and 11 kV Overhead Lines as well as re-conductoring of 33 and 11 kV Overhead Lines as specified herein and in the Attachments. The overhead lines will form part of KPLC's transmission and distribution system.

The Contract Works to be supplied shall be carried out by the Contractor in accordance with the Specification and Condition of Contract and shall comprise the following:

Three-phase overhead distribution lines having the technical particulars set out in the Technical Schedules and Drawings attached to the Specification, the lines being complete with the survey, line conductors, insulators and fittings, poles and crossarms, earthing (where required) and connections, and all other fittings necessary to have a complete distribution line.

5.1.2 Design

The following drawings shall be submitted by the Contractor according to the time schedule for approval:

- · Route maps
- · Longitudinal profiles
- · Tables showing the capacity of the poles related to wind and weight span for the actual conductor sizes
- · Sag tables for the actual conductor types for stringing conditions and included compensation for creep
- · Erection drawings for insulator sets, fittings and cross arms
- · Pole foundation

5.1.3 Factor of Safety

The minimum factor of safety at assumed maximum simultaneous working loading shall be as follows:

i) Line conductors based on ultimate strength

Max tension	3.0
Everyday stress	5.0

ii) Insulator and fittings, based upon electro-mechanical test and minimum failing load

Insulators and insulator fittings	2.5
Dead-end clamps and conductor fittings	2.5

iii) Steel structures, bolts and other steel pole members based on elastic limit of tension members and on crippling loads of compression members:

Steel Structures (Including steel cross arm)	2.5

Bolts, nuts and washers	2.5

iv) Supports, stays and cross arms subjected to the longitudinal transverse and vertical loads resulting in the lading conditions stated above:

Wood supports and cross arms	3.5
Concrete structures	2.5
Steel supports and cross arms	2.5
Stay assembly and fittings	2.5
Foundation – Concrete	2.5

5.1.4 Working Conditions

The maximum assumed working conditions shall be as follows:-

i) Minimum temperature of line $5^{o}C$
ii) Ambient temperature of line conductor $35^{o}C$
iii) Maximum temperature of line conductors $65^{o}C$ ($70^{o}C$)
iv) Wind pressure on the whole projected area of conductors 400N/m2
v) Wind pressure on projected are of insulator 400N/m2
vi) Wind pressure on projected are of support 400N/m2
vii) Altitude: 0 – 2200 meters above sea level.

5.1.5 Clearances and Spans.

NB: The following clearances must be met unless otherwise specified in Specific Project Data.

5.1.5.1 Medium overhead lines minimum clearances at operating temperatures:-

i) Lines not exceeding 11kV across or along road: 5.8m (19ft)
ii) Lines not exceeding 11kV over private land: 5.2m (17ft)
iii) Lines not exceeding 33 kV over private land: 5.8 m
iv) Lines not exceeding 66kV over private land: 6.2m (20ft)

5.1.5.2 Additional Clearances

i) 11 kV line conductor to any part of the building 2.7m (8ft. 8 inch).
ii) 33 kV line conductor to any part of the building) 5m
iii) 66 kV line conductor to any part of the building 7.5 m

5.1.5.3 Special Clearances

a) Railway crossing clearances

i) All types of line including guard nets – 8.1m (30f)
ii) The minimum clearance of any pole or structure from the centre of a tract shall be the height of the pole above ground plus 2.1m (7ft).
iii) Where the tract is in a cutting, no such pole shall be closer to the edge of the cutting than a distance equal to the height of the pole.

b) Kenya Posts and Telecommunications Installation Clearances

i) Guard net – 1.3m (4ft)
Up to 66kV conductors using cradle guard – 1.8m (6ft)

ii) Angles of crossing
Medium voltage, not less than 60°

5.1.6 Environmental Requirements

The Contractor shall undertake to complete all works in accordance with statutory requirements including those of:

i) The Kenya Wildlife (Management and Conservation Act) Applicable for all works inside National Parks.
ii) The Kenya Agricultural Act - Concerning protection against soil erosion.
iii) Public Health Act – Concerning with noise, water and air quality as they relate to human health.
iv) Chief Authority Act – Concerning the regulation of timber cutting and wasteful destruction of trees and avoidance of damage to the public road or other community facilities.
v) The Local Government Act – Section 145 for preservation or protection of wildlife and Section 163 regarding noise disturbance controls.

The Contractor shall take reasonable precautions to avoid damage to land, property, crops, etc. and shall ensure that the work is adequately supervised so that damage is reduced to the minimum. All surplus material shall be removed after erection and site shall be left in a clean and tidy condition, to the satisfaction of the Purchaser.

Where the Contractor considers that damage cannot be avoided if the work is to proceed normally he shall notify the Purchaser accordingly. The Purchaser will coordinate and facilitate assistance with the landowner concerned during negotiations for compensation. The Contractor will be responsible for compensation in respect of damage and the Contractor shall proceed with the work within the limits indicated by the Purchaser.

Where temporary removal of bound, wall or similar obstacles is necessary for the purpose of foundation installation or support erection, the cost of removal and subsequent reinstatement shall be deemed included in the Contract rates for foundation and support erection.

Where it is necessary to provide scaffolding over roads, railways or telecommunication lines in order not to interfere with the passage of traffic, this shall be carried out by the Contractor at such times as may be convenient to the Authority concerned. Flagman and approved types of danger and warning notices shall be provided by the Contractor to ensure safety of the public.

5.1.6.1 Wayleaves

Wayleaves shall be provided by the Purchaser to enable the Contractor to carry out the Works. In order to provide wayleave the Purchaser has to obtain approvals from Government and other statutory authorities, and also consents from owners and occupiers of property which will be affected by the lines.

The procedure for obtaining approvals and consents is dependent on preliminary profile survey, as described below:

a) Representatives of the Purchaser will accompany Contractors staff during preliminary survey. The Purchaser’s representatives will issue notices to and liaise

with landowners and occupiers in order to establish rights of entry for survey and agreement to limited cutting of vegetation as specified.

b) Upon approval by the Purchaser of preliminary survey the Purchaser will initiate procedures for obtaining wayleave, and when necessary approvals and consents have been granted the Purchaser will arrange for trees etc. to be cleared from the line route as specified.

c) Upon approval by the Purchaser of the position of support centre pegs the Contractor shall submit access maps as specified and the Purchaser will obtain the necessary rights of construction access for the Contractor.

d) Wayleaves procedures as described above will take place concurrently with profile survey, approval of centre pegs, etc. The Contractor shall allow in his programme for a period of up to two months from approval of preliminary lines to the grant of right of access for its construction.

e) Any conditions for the wayleave should be made known to the Contractor.

f) The wayleave procedures shall lead the construction programme for each section of the Contract.

5.1.7 Standards

Unless another standard is mentioned in this Specification, all materials used and provided under this contract and all services performed must be in accordance with the latest amendments of the Standards of the International Electro-technical Commission (IEC) or British Standards (BS), applicable Kenyan Standards and the attached Material Specifications.

Suppliers who do not normally manufacture to IEC or BSI Standards may offer equipment in accordance with other recognized national Standards provided that they draw attention to any essential differences between their Standards and IEC/BSI Standards and Subject to the satisfaction of the Employer that the quality, finish and performance of the equipment complying with such standards shall be comparable to that complying with IEC or BS.

5.1.8 Units of Measurements

SI units (System International) shall be used in all the technical schedules and drawings.

5.1.9 Materials

Each of the several parts of the line shall be of such construction and design as to give long and continuous service with high economy and low maintenance costs.

All material used and equipment provided under this contract shall be new and of the best quality and workmanship and shall be of the highest class throughout with the designs and dimensions of all parts such that mechanical and electro-mechanical stresses which they are subjected shall not render them liable to distortion or damage under most severe conditions encountered in service. Repair of any defective parts shall not be permitted without the sanction in writing of the Project Manager.

The detailed design shall be carried out in manner to facilitate inspection, repairs and simplicity of operations and maintenance. All materials shall ensure satisfactory operations under the atmospheric conditions prevailing in the area where the lines are

to be built, irrespective of season and under such variations of load and voltage as may occur under working conditions of the system. Line supports, conductors, insulators and fittings shall be such as to minimize the risk of damage due to deterioration, or damage in service of any part of the line. The design shall incorporate any reasonable precaution and provision for the safety for those concerned in the maintenance of the Contract Works and all associated works supplied and executed under other contracts.

All corresponding parts shall be made to gauge, shall be inter-changeable wherever possible throughout the Contract Works and are to be such as will facilitate the fitting of replacement.

5.1.10 Line Supports and Foundations

The network shall be supported on 15M concrete poles. The concrete poles shall meet the specifications set in Kenya Power and Lighting Co. Ltd; Specifications for Concrete Pole Kenya Standard DKS 1933.

The poles can be of single pole type or H-pole type, with or without stay wires, with insulator chains or pin or post insulators, depending on the actual conditions and the approved design.

NB:<u>The following Parts (5.1.10.1, 5.1.10.2 & 5.1.10.3) on wooden poles is not Applicable</u>

5.1.10.1 Physical and Mechanical Properties of Wood poles-

The wood poles (Eucalyptus Saligna) used shall have the following properties:-

Nominal length	10	11	11	12	12	14	14
Category	Medium	Medium	Stout	Medium	Stout	Medium	Stout
H(mm)	1.8	1.8	1.8	1.8	1.8	2.0	2.0
D_c(mm)	220	230	295	240	305	248	310
D_m(mm)	150	160	200	160	200	160	200
D_g(mm)	220	230	295	240	305	270	335
D_e(mm)	175.9	185.6	234.8	189	238.1	199.4	248.4
F(kN)	5.90	4.94	13.05	4.03	10.37	3.45	8.23
Ultimate load (kN)	8.64	8.73	18.42	8.89	18.24	10.46	20.02
Crippling load (kN)	59.4	58.6	149.8	51.2	128.9	45.9	110.3

H Ground position from butt
d_c Critical diameter
d_g Minimum groundline diameter (mm)
d_m Minimum top diameter (mm)
d_e Effective diameter
f Load per mm of deflection at point of application of load

Note that the mechanical properties used in the mechanical calculations are those stated in the Kenya Standard KSO2-516.

5.1.10.2 Strength and Species

Wood poles shall be of eucalyptus timber and shall belong to the strength groups Light, Medium or Stout as specified. The treatment shall be creosote pressure-treated wood,or Chromated copper arsenate (CCA).

5.1.10.3 Pole Caps

Pole caps of approved type shall be used.

5.1.10.4 Safety

All poles shall have a DANGER/HATARI warning plate, placed at a visible point in the pole at a height of 1.7m and legible from a distance of at least 2m.

5.1.10.5 Excavation

The hole for the pole shall be excavated to a minimum of 1.8m for the 11m pole. If the base of the hole is not firm ground, the hole shall be excavated until firm ground is reached, otherwise the pole has to be placed on a flat rock block, min. 40 x 40 cm or a timber raft, min 80 x 80 cm., depending on the conditions.

The minimum hole depth for wood poles shall be defined in the table:-

Pole Height H (m)	Size	Hole Depth Minimum (m)
10	Medium	1.6
11	Medium	1.8
11	Stout	1.8
12	Medium	2.0
12	Stout	2.0
14	Medium	2.2
14	Stout	2.2
15	Stout	2.4
17	Stout	2.6

The hole shall be dug to the required depth. Any holes left overnight must be covered in such a way that they do not pose any danger to persons or animals. A suitable method of warning shall be used to identify positions of the holes.

5.1.10.6 Erection

The butt of the pole is laid over the hole with the length in the direction of the line. A skid board is placed against the hole to facilitate the entry of the butt when the pole is raised and prevent earth breaking into the hole during the process of erection.

Erection of the poles shall be done using any of the following methods:

i) Erection ladders
ii) Truck mounted hydraulic lifts
iii) Guy ropes shall be used to prevent accident and to hold pole in a true vertical position. The pole is gradually raised to the vertical position and the butt guided in to the hole.

5.1.10.7 Pole Dressing

Partial dressing can be done while the poles are lying on the ground; in this case care must be taken during erection to avoid the fittings being damaged. The fitting of the insulator shall be done after the pole has been erected.

5.1.10.8 Back Filling

After erecting the pole and positioned it vertically, the pole shall be secured in this position by help of stones blocks placed in 2 or 3 layers, one layer at the bottom of the hole, and one to two layers at the top. The stones shall fill out the area between the pole and the wall and will secure that the pole remains vertical during the pole's lifetime.

Between the layers of stone and above the top layer, the excavated soil can be used as backfill material if the origin soil is appropriate for tamping.
The soil should be wet and backfilled slowly and each layer thoroughly tamped until the tamp makes a solid sound as the earth is stuck. Each tamping layer should not exceed 150 mm. If small stones or gravel are readily available, these should be mixed with the soil used in backfilling.

In areas where the ground is unsuitable for firm erection of poles i.e. swampy areas with black cotton soil etc the pole has to be placed on a flat rock block or on timber raft as described under Excavation on previous page. It may also be necessary to change out the soil material around the pole.

5.1.10.10 Design, Materials and Construction of Concrete Poles

The concrete poles shall be designed and manufactured in accordance with Kenya Standard DKS 1933.

The poles shall be round, Prestressed or Reinforced Concrete Poles as per DKS 1933.

The materials used shall be in conformity with the design standard (DKS 1933) and shall be selected to suit intended application.

The pole shall be so designed that its strength in transverse direction shall be sufficient to take the load due to wind on conductors, fittings and the pole.

In accordance with Annex A of DKS 1933, the aggregates used in the manufacturer pf the pole shall be free from veins and adherent coating and free from injurious amount of disintegrated pieces, alkali, vegetable matter and other deleterious substances. As far as possible, flaky, sconaceous and elongated pieces shall be avoided.

The surface of all reinforcement shall be free from loose scale, oil, grease, clay or other material that may have deleterious effect on the bond between the reinforcement and concrete.

The mix design, mixing and compaction of the concrete shall be such that the necessary strength in the pole is obtained after curing in accordance with DKS 1933.

Concrete shall be compacted by vibration, centrifugation or other efficient means. Hand compaction shall not be permitted.

The finished pole shall have a smooth external surface that is free from honeycombing.

A quarter (¼) of the poles supplied for each consignment shall incorporate an integral earthing system comprising a non stressed internal earthing copper conductor (at least 70mm² stranded conductor) running the length of the pole and the ends of the conductor shall be left projecting from the pole to a length of 100mm at 200mm from top and 150mm below ground level. Manufacturer may offer alternative suitably designed earthing termination for consideration.

5.1.10.11 Physical and Mechanical Properties of Concrete Poles

The concrete poles shall conform to the following standard sizes:

Nominal Length (m)	Top Diameter (mm)	Working Load (kN)	Ultimate Load (kN)	Strength Class (as per DKS 1933)	Minimum Depth in Ground (m)
10	190	2.5	5	50	1.8
11	190	2.5	5	50	1.8
12	190	3.0	6	50	1.8
13	190	3.0	6	50	2.0
15	190	3.0	6	50	2.1

The required safety factor is 2.5 and pole taper for the Prestressed Concrete Pole shall be at least 13mm per meter.

Poles shall be supplied complete with suitably designed fittings for conductor and stay wire characteristics.

5.1.10.12 Marking

Each concrete pole shall be marked permanently by impressing on the pole (or by use of a permanently secured plate) at a position 1.5m above the pole Ground line with the following details:

- Manufacturer's name
- Date of manufacture (mm/yy)
- Length of pole (meters) and Tip dimensions (mm)
- Ultimate/Working load/Strength Class
- Type of pole
- Weight of pole
- Standard to which the pole complies
- The words "PROPERTY OF KPLC"

Ground line reference mark shall be conspicuous on the pole.

Where a plate is used it shall be made of stainless steel, securely affixed to the pole. In all cases the lettering shall be not less than 5mm high legibly impressed.

5.1.10.9 Bolts Nuts and Washers

All bolts and nuts shall confirm to BS 4190 and shall preferably have screwed threads of I.S.O. form. Nuts and heads of all bolts shall be of the hexagonal type. All bolts and screw rods shall be galvanized including the threaded portion. Al nuts shall be galvanized with the exception of the threads, which shall be oiled.

5.1.11 Insulators and Fittings

5.1.11.1 Insulators

Insulation between conductors and support shall be of both disc, pin and post insulators and shall comply in all respects with IEC 305, 383 and 120, 1109 and 815 or such other standard as may be approved and with the requirements set out in this Specification and in the Technical Schedules.

Insulator units shall be glazed porcelain or composite type by approved manufacturers who shall have had at least ten yeas experience of supplying complete insulator units to international purchasers. Technical particulars and service histories must be submitted for the type of insulator offered. Insulator units shall where possible be interchangeable with units already in use on the Employer's system.

All insulators shall be designed with a view to service in a tropical climate in an area subject to lighting storms, at an altitude of about 2200 m above sea level.

Insulator strings shall consist of minimum quantity of 6 units for 66kV, 3 units for 33 kV and 2 units for 11kV at 146 mm centre distance between each disc. The actual numbers and types of discs shall be selected to suit the requirements set out in the technical schedules.

Locking devices for the insulator units themselves and for associated ball and socket and fittings shall be of stainless steel and shall comply with IEC 372. The assembly shall be such as to allow easy removal for replacing of insulator units or fittings without the necessity to remove the insulator string from the crossarms.

All ball and socket joints on insulator sets shall be lightly coated with approved grease before erecting.

Each insulator shall be marked with the name or trade mark of the manufacturer and the year of manufacture in accordance with IEC Publication 60383. In addition, each insulator shall be marked with the specified electromechanical or mechanical failing load in conformity with IEC Publication 60383.

5.1.11.2 Insulator Fittings

Fittings shall comply with BS.3288: Part 1 or such other standard as may be approved and shall be so designed that replacement of string insulator units and the arcing protection system can easily be performed during maintenance or repair under outage or live-line conditions.

All clamps shall be as light as possible and shall be designed to avoid any possibility of deforming the stranded conductors and separating the individual strands.

Bolts and nuts shall be in accordance with an approved specification. Bolt threads shall be coated with approved grease immediately before packing. Split pins for securing attachment of fittings of insulator sets shall be of stainless steel and shall be packed by washers of approved size and gauge.

All insulator strings shall be attached to crossarms by means of shackles or swivels. Hooks shall not be used.

5.1.11.3 Pin Insulators

Pin insulator shall be used for intermediate line poles and for small angles up to 20°.

On pin insulators, the conductor shall be bound in on top of the groove, using two suitable stirrups in each case. The bind shall be formed of a single layer of closely wound wire, extending at least 25 mm beyond the stirrups. The bind shall be wound on opposite directions, on each side of the insulator.

With aluminium conductor, the bind shall be formed of two stirrups, with 2.5 mm diameter aluminium binding wire. In addition, aluminium amour tape shall be used, wrapped in a direction opposite to that of the conductor lay. The amour tape shall cover the portion of the conductor that is in contact with the insulator, and extend at least 40 mm under the bind.

5.1.11.4 Porcelain Disc Insulators

Porcelain discs insulators will be used where increased tensile strength in the conductors is envisaged i.e. flying angles, section and terminal poles.

The table below gives creepage distance requirement in relation to pollution

Type of pollution	Creepage distance
Low	18-22 mm/kV
Medium	22-35 mm/kV
Extreme	> 35 mm/kV

Where there is severe lighting activity, high insulation and creepage values are necessary.

5.1.11.5 Post Insulators

Post insulators will be used for 66 kV lines in high pollution areas.

5.1.12 Cross Arms

The following types of cross-arms shall be used depending on the limiting factor:

5.1.12.1 Steel Cross Arms

Steel cross
arms shall be used in all cases as required.

Steel Crossarms shall be used extensively in the line making different formations. The choice of the formation will be determined based on the following:

i) Environmental conditions
ii) Landscape
iii) Available space

The steel crossarm shall be suitable for continuous operation outdoors in tropical areas at altitudes of up to 2200m above sea level, humidities of up to 90%, average ambient temperature of +30ºC with a minimum of -1ºC and a maximum of +40ºC and saline conditions along the coast.

5.1.12.1 Materials

Structural steel used, shall be grade 43A as specified in the BS 4360: “Specification for weldable structural steel”.

The tensile strength and yield stress of the steel shall be not less than 430/510 N/sq. mm and 255 N/sq. mm respectively.

Angle sections shall be as per BS 4848

Channel sections shall be as per BS 4

5.1.12.2 Welding

Welding where specified shall be by metal-arc welding and shall be as per BS 5135.

After welding and before galvanising, welds shall be thoroughly cleared to remove slag and spatter, preferably by sand blasting.

All materials before and after fabrication shall be straight and free from twists. The material shall be free from blisters, scale and other defects.

All dimensions specified shall be subject to the following tolerances, unless otherwise stated.

(i) Dimensions up to and including 50 mm: ±1 mm

(ii) Dimensions greater than 50 mm: ±2 mm

Erection clearance for cleated ends of members connecting steel to steel shall not be greater than 2mm at each end.

Bolt holes shall not be more than 2mm greater than the diameter of the bolt for bolts up to 24mm diameter.

Cutting may be by shearing, cropping, sawing or machine flare cutting. Sheared or cropped edge shall be dressed to a neat finish and be free from distortion where parts are to be in metal contact.

All holes shall be drilled in one operation and burrs shall be removed. Holes shall not be formed by a gas cutting process. All matching holes for bolts shall register with each other so that a gauge 2mm less in diameter than the diameter of the bolt shall pass freely through the assembled members in a direction at right angle to such members.

5.1.12.3 Galvanizing

All materials to be galvanized shall be of the full dimensions shown or specified and all punching, cutting, and the removal of burrs shall be completed before the galvanizing process commences.

All galvanizing shall be done by the hot dip process with spelter, not less than 98% of which must be pure Zinc and in accordance with BS 729.

The Zinc coating shall be uniform, clean, smooth and as free from spangle as possible.

Galvanized steel structures shall be treated after galvanizing with Sodium Dichromate Solution.

Galvanizing

	Steel Structures for Inland installations
Minimum Average Coating Weight	610 g/m²

Bending of flat straps shall be carried out cold.

5.1.12.2 Standard Sizes

The standard sizes of the different cross arms shall be as shown on the table below:-

APPLICATION	**Standard Length (mm)**	**CROSS SECTION**		
		Height (mm)	Width (mm)	Thickness
11kV interpole. Up to 150mm^2 conductor.	1626	70	70	9.5
11kV Section/Angle up to 60$^{o//\ terminal}$. Up to 150mm^2 conductor.	2290	125	70	9.5
33kV Interpole	2400	100	76	9.5
33kV Section/Angle pole/ Terminal	2400	125	76	9.5

5.1.12.3 Markings

The cross arms shall be marked legibly and indelibly on an aluminium tag size not less than 400mm x 200mm fixed at a distance of between 150mm and 350mm from the end. The thickness of the aluminium shall not be less than 0.9mm (SWG 20).

The tag shall be stamped with the following information:-

i) Identification mark or name of the plant where cross arm was treated.
ii) Date of treatment, comprising the first two digits for the month and the last two digits for the year.

The letters and figures shall be at least 10mm high.

5.1.13 Line Formation

The following is a recommendation for the use of the different common line formations:

i) Line poles for deviations 0°-10°, Steel cross arm will be used for horizontal and delta formations.
ii) Line poles for deviation 20^o-60^o, double cross-arms or vertical flying angle shall be used.
iii) Line poles for deviations greater than 60^o, vertical sections shall be used.

5.1.14 Stay, Stay Insulators and Stay Blocks

5.1.14.1 Stay

Stay wires shall be in conformity with the attached Specification for Stay Wires and Guy Grips.

The dimension of stay wires used shall be in accordance with the actual load taking into consideration the Safety Factor given.

The stay wires shall with first-class workmanship be fastened to the pole to assure that they are keeping the pole in a vertical position during the pole's lifetime.

5.1.14.2 Stay Insulator

A sling type strain insulator shall be inserted in each stay 1.6m from the top.

5.1.14.3 Stay Block

A reinforced concrete stay block buried to the depth of 1.4m shall be used as the stay anchor.

5.1.15 Conductor

Phase conductor to be used shall be Aluminium Conductor Steel Reinforced (ACSR) or All Aluminium Alloy Conductors (AAAC) in case of 66Kv lines and shall consist of steel strands together with aluminium strands or aluminium alloy strands only.

The outermost layers of the conductors shall be stranded with right hand lay. There shall be no joints in the individual wires of the outer layers of the aluminium wire.
The requirements for the conductors are specified in the attached Specification for Aluminium Alloy Conductors and Specification for Aluminium Conductor Steel Reinforced.

5.1.15.1 Conductor Characteristics

The conductors shall conform to the following:

16.a PHYSICAL CHARACTERISTICS

Nominal Al. area (mm^2)	Code Name	Steel No./mm^2	Alum. No/mm^2	Over all dia. (mm)	Calculated Al. equ. Area (mm^2)	Total cond. Area (mm^2)	Weight Kg/Km	Copper Equiv. Area (sq.in)
150	Wolf	7/2.59	30/2.59	18.1	154.3	195.0	727	0.15
300AAA	Upas		37/3.53	24.71		362.1	997	0.3

16.b ELECTRICAL CHARACTERISTICS

Nominal Al. area (mm^2)	Tensile Strength kgs	Resistance at 20 °C Ohm/Km	Current Rating Amp	Inductive reactance ohm/Km Spacing	
				30cm	50cm
150	6880	0.1844	430	0.235	0.266
300	10600	0.09155	610		

The current ratings are based on the following operating conditions:

Ambient temperature : 35°C
Maximum conductor temperature : 75°C
Intensity of solar radiation : 0.089 w/cm2

5.1.15.1.1 Conductor Joints, Termination's

All joints and terminations **shall be of compression type** for conductors of 150mm2 and above.

5.1.15.1.2 Suspension Clamps

Suspension clamps shall be suitable for use on aluminium conductor steel-reinforced (ACSR) or AAAC of 18.2 mm diameter (150 sq. mm) and above and shall be of the following types.

(a) Clevis ended hook type and pivoted type (similarly known as envelope type and trunnion type respectively).

(i) The clamp body and keeper piece shall be of high strength, heat-treated cast aluminium alloy.
(ii) The clamp cotter bolts, hangers, brackets and U-bolts shall be of galvanised steel and the cotter pin shall be of stainless steel.

(b) Angle suspension clamp type (similarly known as side opening type).

(i) The clamp shall be suitable for use on turning angles from 10 to 120 degrees.
(ii) The clamp body and keeper shall be of malleable iron or ductile iron, hot dip galvanised to BS 729.
(iii) The clamp cotter bolts and bolt shall be galvanised steel and the cotter pin shall be stainless steel.

5.1.15.1.3 Connectors

The connectors shall be suitable for use on stranded bare conductors and shall correctly fit the conductor it is intended for use.

The connector shall have adequate cross sectional area and dimensions and shall have current carrying capacity at least equal to the capacity of the conductor it is intended for.

(a) Aluminium connectors

(iv) Aluminium connectors (line taps) shall be suitable for connecting stranded aluminium conductors

(v) The connector shall be manufactured from electrolytic, high strength aluminium.

(b) Copper connectors

Copper connectors shall be suitable for connecting stranded copper conductors.

(c) Bi-metal connectors

(vi) Bi-metal connectors shall be suitable for connecting stranded aluminium conductors to stranded copper conductors.
(vii) The bi-metal connector shall be designed to provide an effective corrosion barrier between the dissimilar metals (aluminium and copper).

5.1.15.2 Drums

Drums for conductors shall be stoutly constructed of good quality timber or steel and clearly marked with length and type of conductor in a manner not easily removable. Drums shall be securely battened around the perimeter and shall be lined with approved impervious material to prevent contact between the contents and both the drum itself and any chemicals with which the drum has been treated.

All timber drums and battens shall be protected from deterioration on site by termite or fungus attack by an approved impregnation treatment at the works before dispatch. Such substance shall not be harmful to the conductor.

All drums shall have spindle holes of adequate diameter and be stoutly reinforced with steel plate.

The cut ends of the conductor shall be properly secured to the flange of the drum and shall be treated in an approved manner to prevent the ingress of moisture during transit or storage.

The Contractor shall deliver all empty drums to the employer's store. All drums are non returnable and shall remain the property of the Employer.

5.1.15.3 Markings of Drums

The following particulars will be indelibly stencilled on both flanges of every drum:

(i) Contract title and reference number
(ii) Manufacturer's name
(iii) Direction of rolling
(iv) Lifting instructions and limitations

An aluminium nameplate shall be fixed to each drum clearly showing the following:-

(A) Conductor materials and stranding
(B) Length of conductor
(C) Net weight
(D) Gross weight
(E) Manufacturers batch number
(F) Manufacturers drum number
(G) Winding date
(H) Approximate measurements

5.1.15.3.1 Conductor Stringing

All stringing equipment shall be properly anchored and shall be positioned in such a way that structures, insulators and fittings will not be overloaded.

Every precaution is to be taken to prevent damage to the conductor. Clamps and other devices used for handling the conductor during stringing shall allow no slippage or relative movement of strands or layers and shall not pinch or deform the conductor. Conductor grooves in sheaves and tensioner shall be lined with neoprene or rubber.

Conductors shall be effectively earthed in an approved manner during running out and at all places where men are working on them.

Conductor drums shall be closely examined before conductor pulling commences and all nails and other things that could damage the conductor shall be removed.

5.1.15.4 Reconductoring

Before the re-conductoring commence, the Contractor shall inspect the line and check that the clearances to ground, trees, houses, roads etc meet the requirements. He shall also check that :

- The capacity of poles, cross arms and stay wires is sufficient for the new conductor
- The quality of poles, cross arms and stay wires is satisfactory
- The pole heights are sufficient for the new conductor
- The poles are in vertical position

Where the existing installation not meet the above requirements, change out of material or aligning work of poles have to be carried out.

When re-conductoring, the Contractor has to handle all tilted poles with outmost care. Before loosen the existing conductors, the poles have to be secured with stay wires. Climbing the poles has to be done by use of ladders placed against the tilted direction.

All tilted poles has to be corrected to a vertical position before the stringing work of the new conductors starts. Poles that do not meet capacity- or quality-wise meet the new requirements have to be changed out.

After aligning the poles, the top of the pole shall not be out of the vertical axis by more than the top pole diameter.

All clamps, fittings and details not suiting the new conductors or quality-wise not meet the requirements, shall be changed out.

5.1.16 Safety

Personnel shall be required to use necessary protective gear, which conform to applicable codes.

Personnel working near high voltage areas shall be required to use non-slip foot wear, gloves, safety glasses, helmets, etc. They shall also be required to observe stipulated safety clearances.

Fire prevention and safety programmes shall also be observed.

5.1.17 Operation Devices and Protection Systems

Operation devices consisting of single and three pole disconnectors shall be installed at locations specified by the designer. The disconnectors shall be easily accessible during

normal conditions. They will be fixed in such a way that they cannot be closed by the action of gravity. Their characteristics shall be capable of meeting the maximum rated current of the circuit.

5.1.17.1 Isolation

5.1.17.1.1 Air break Switches

Air break switches shall be used to interrupt small currents (up to 10% of rating of ABS).

5.1.17.1.2 Protection Against Overvoltage

Protection against overvoltage will consist of surge diverters at locations specified by the designer.

5.1.17.1.3 Protection Against Overcurrent

The network comprises main line and spurs.
Circuit breakers shall be installed at the beginning of the main line at the primary substation.

Short circuit fuses shall be installed at the beginning of the primary spur.
Autoreclosers and sectionalizer shall be located as specified by the designer.

5.2 SPECIFICATION FOR ALL ALUMINIUM ALLOY CONDUCTORS

5.2.1 Scope

This specification is for aluminium alloy stranded conductors (300mm²) for overhead power transmission.

5.2.2 References

The following document was referred to during the preparation of this specification; in case of conflict, the requirements of this specification shall take precedence.

IEC 61089: Round wire concentric lay overhead electrical stranded conductors.
BS 3242: Specification for Aluminium Alloy Stranded Conductors for Overhead Power Transmission.

5.2.3 Terms and Definitions

For the purpose of this specification the definitions given in IEC 61089 shall apply.

5.2.4.1 Materials and Construction

5.2.4.1.1 The conductor shall be designed and manufactured in accordance with IEC 61089 and the requirements of this specification.

5.2.4.1.2 The conductor shall be made of aluminium-magnesium-silicon alloy wires designated A2 as per IEC 61089.

5.2.4.1.3 The resistivity of the wires shall be 32.530nΩm (corresponding to 53% IACS) as per IEC 61089.

5.2.4.1.4 The conductor shall be concentrically stranded, with successive layers in opposite lay, but such that the outer layer shall be in the right hand spiral (Z). The wires in each layer shall be evenly and closely stranded around the underlying wire or wires.

5.2.4.1.5 The conductor shall have grease applied to the centre and outer wires as protection against corrosion.

5.2.5 Standard Sizes and Characteristics

The standard sizes and characteristics for the conductor shall be as follows:

Nominal Aluminium area (mm²)	300
Stranding and wire diameter (No/mm)	37/3.53
Sectional Area (mm²)	362.1
Approximate overall diameter (mm)	24.71
Approximate mass per km (kg)	997

Calculated d.c. Resistance at 20°C per km (Ω)	0.091 55
Calculated breaking load (kN)	101.5

Note: (1) The Current Carrying Capacity of the conductor shall be stated by the manufacturer in the clause-by-clause statement of compliance as per Appendix A.

(2) The above table is for conductors for existing/established designs of overhead lines as allowed by clause 5.2 of IEC 61089.

5.2.6 Tests and Inspection

The conductor shall be inspected and tested in accordance with the requirements of this specification and IEC 61089. It shall be the responsibility of the manufacturer to perform or to have performed the tests specified and whatever other tests he normally performs at works.

Certified true copies of type test reports by the relevant National Testing/Standards Authority of the country of manufacture (or ISO/IEC 17025 accredited laboratory) shall be submitted with the offer for evaluation (all in English Language).

Routine and sample test reports for the conductors to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods.

5.2.7 Marking, Labelling and Packing

The finished conductor shall be wound on wooden drum such as to prevent damage during transportation and handling. The drums shall be made from treated timber resistant to termite attack.

The actual length of conductor shall not be less than the length indicated on the drum.

Both ends of every drum length of conductor shall have been sealed to prevent the ingress of water during transportation, storage, handling and installation. Both ends shall be secured to the drum to prevent mechanical damage.

The following information shall be marked legibly and in a permanent manner on the flange of the drum:

The manufacturer's name;
The type and rating of conductor;
The conductor cross-sectional areas in mm²;
The length of the conductor, in metres;
The year of manufacture;
The gross mass and net mass, in kilogram;
The instructions for handling and use (in the English Language);
The words "**PROPERTY OF KENYA POWER & LIGHTING CO**."

5.3 OVERHEAD ALUMINIUM CONDUCTORS STEEL- REINFORCED.

5.3.1 Scope

a) This specification is for Aluminium conductors Steel Reinforced for medium voltage overhead power distribution lines.
b) This specification covers the following conductor sizes.

25 Sq. mm Aluminium Conductor Steel Reinforced
25 Sq. mm Aluminium Conductor Steel Reinforced, Polyvinyl Chloride (PVC) cover
75 Sq. mm Aluminium Conductor Steel Reinforced, bare
150 Sq. mm Aluminium Conductor Steel Reinforced, bare

5.3.2 References

The following documents were referred to during the preparation of this specification, and may be referred to. In case of conflict, the provision of this specification shall take precedence.
Unless otherwise specified, the latest revision, edition and amendments shall apply.
BS 215: Aluminium conductors and Aluminium conductors steel - reinforced for overhead power transmission

5.3.3 Aluminium conductors, steel - reinforced

BS 2627: Wrought Aluminium for Electrical purposes
BS 4565: Galvanised steel wire for Aluminium conductor steel reinforced.
BS 6746: PVC Insulation and sheath of electric cables
BS 6485: PVC covered conductors for overhead power lines.
IEC 209: Aluminium conductors, steel - reinforced

5.3.4 Terms And Definitions

For the purpose of this specification, the definitions in the reference standards shall apply.

5.3.5 Materials

Aluminium wires used in the construction of the conductor shall be GIE grade H9 as specified in BS 2627: Wrought Aluminium for Electrical purposes.
The galvanised steel wires used in the construction of the conductor shall be as per BS 4565: Galvanised steel wire for Aluminium Conductors - Steel Reinforced.

5.3.6.1 Construction

5.3.6.1.1 The conductor shall be manufactured as per BS 215 part 2:1970.

5.3.6.1.2 The conductor shall be concentrically stranded, with successive layers in opposite lay, but such that the outer layer shall be in the right hand spiral (Z) Variation in diameter shall not exceed ±1% of aluminium wires, and ±2% of steel wires.

5.3.6.1.3 The wires in each layer shall be evenly and closely stranded.

5.3.6.1.4 For the bare conductor, An approved grease shall be applied at least to the centre and outer wires as protection against corrosion.

5.3.6.1.5 For the covered conductor, the insulation shall be black polyvinyl chloride (PVC) compound type T II as per BS 6746;1976 and shall be applied by extrusion.

5.3.6.1.6 The insulation shall have a thickness of not less than 1.6mm and the covered conductor shall comply with the requirement of BS 6485: 1971.

5.3.7 Standard Sizes

The Standard Sizes for the aluminium and steel wires used in the construction of the conductors and the conductors sizes shall be as follows:-

CONDUCTOR	Bare (Golpher)	PVC Covered	Bare (Racoon)	PVC Covered	Bare (Wolf)
Nominal Area of Aluminium (mm²)	25	25	75	75	150
Approximate overall diameter (mm).	7.08	7.08	12.3	12.3	18.13
Overall diameter of covered conductors.	-	10.7		16.3	
Stranding No/mm Al.	6/2.36	6/2.36	6/4.09	6/4.09	30/2.59
St.	1/2.36	1/2.6	1/4.09	1/4.09	7/2.59
Calculated maximum d.c. resistance at 20°C (/Km)	1.093	1.093	0.3633	0.3633	0.1828
Calculated minimum breaking load (k.N)	9.61	9.61	27.4	27.4	69.2
Approximate mass of conductor (Kg/Km)	106	190	318	460	726

5.3.8 Tests

a) The conductor shall be inspected and routine tested in accordance with the requirements of BS 215 Part 2.
b) The following tests shall be done at manufacturers works.

5.3.9 Aluminium Wires

Tensile test
Wrapping test
Resistivity test

5.3.10 Steel Wires

Determination of stress at 1% elongation
Tensile test
Wrapping test
Galvanising test

5.3.11 Conductor test

Lay ratio of each layer
Tensile strength
Measurement of weight
Resistance test

5.3.12 Conductor Accessories

i) Tension joints shall be applied at appropriate locations
ii) Torsion sleeve joints shall be used for mid-span joint. This should be able is designed to withstand full tension of the line.
iii) Non tension joints shall be applied at appropriate locations
iv) Parallel Groove (PG) CLAMP shall NOT be used

5.3.13 Conductor Stringing

Conductor running out shall be done with all necessary care to avoid kinking, nicking of various strands and chuffing of the conductor between the drum and the snatch blocks.

5.4 SPECIFICATIONS OF PVC COVERED COPPER CONDUCTORS

5.4.1 Scope

This specification is for copper conductors for earthing power distribution and transmission system.

This specification covers the following conductor sizes.
50 Sq. mm stranded copper conductor, PVC covered.
70 Sq. mm stranded copper conductor, PVC covered .
100 Sq. mm stranded copper conductor, PVC covered.

5.4.2 References

The following documents were referred to during the preparation of this specification, and may be referred to. In case of conflict, the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply.

BS 125: Hard – drawn copper and copper – cadmium conductors for overhead power transmission purposes.

BS 6485: PVC – covered conductors for overhead power lines.
BS 6746: PVC insulation and sheath of electric cables.
BS 4109: Specification for copper for electrical purposes. Wire for general electrical purposes and for insulated cables and flexible cords.

5.4.3 Terms and Definitions

For the purpose of this specification, the definitions in the reference standards shall apply.

5.4.4.1 Materials

5.4.4.1.1 Copper wires used shall be high conductivity hard drawn copper wires. The wires shall be clean, smooth and free from harmful defects.

5.4.4.1.2 The conductor cover shall be black polyvinyl chloride (PVC) compound Type TII according to BS 6746 and shall be applied by extrusion.

5.4.4.1.3 The insulation shall have a thickness of not less than 0.8 mm and the covered conductor shall comply with the requirement of BS 6485.

5.4.5.1 Construction

5.4.5.1.1 The conductor shall be manufactured as per BS 6485.

5.4.5.1.2 The conductor shall be concentrically stranded, with successive layers in opposite direction of lay, but such that the outer layer shall be in the right hand spiral. The wires in each layer shall be evenly and closely stranded.

5.4.6 Standard Sizes

The Standard Sizes for copper conductors shall be as follows:-

CONDUCTOR			
Nominal Area of Copper (mm²)	50	70	100
Approximate overall diameter of uncovered conductor(mm).	9.00	10.65	12.9
Approximate overall diameter of covered Conductor (mm).	11.9	13.5	15.7
Stranding No/mm	7/3.00	7/3.55	7/4.30
Calculated maximum d.c. resistance at 20°C (□ /Km)	0.3606	0.2575	0.1804
Breaking load (N)	19497	26880	37640

5.4.7 Tests

The conductors shall be inspected and routine tested in accordance with the requirements of BS 6485 and BS 125.

The following tests shall be done at manufacturers works.

Tensile test
Resistivity test
Lay ratio of each layer
Tensile strength
Measurement of weight
Resistance test

5.5 SPECIFICATIONS OF BARE COPPER CONDUCTORS

5.5.1 Scope

This specification is for copper conductors for earthing power distribution and transmission system.

This specification covers the following conductor sizes.
100Sq. mm stranded copper conductor
15 Sq. mm stranded copper conductor

5.5.2 References

The following documents were referred to during the preparation of this specification, and may be referred to. In case of conflict, the provision of this specification shall take precedence.

Unless otherwise specified, the latest revision, edition and amendments shall apply.

BS 125: Hard – drawn copper and copper – cadmium conductors for overhead power transmission purposes.

BS 4109: Specification for copper for electrical purposes. Wire for general electrical purposes and for insulated cables and flexible cords.

5.5.3 Terms and Definitions

For the purpose of this specification, the definitions in the reference standards shall apply.

5.5.4 Materials

Copper wires used shall be high conductivity hard drawn copper wires.
The wires shall be clean, smooth and free from harmful defects.

5.5.5.1 Construction

5.5.5.1.1 The conductor shall be manufactured as per BS 125.

5.5.5.1.2 The conductor shall be concentrically stranded, with successive layers in opposite direction of lay, but such that the outer layer shall be in the right hand spiral. The wires in each layer shall be evenly and closely stranded.

5.5.6 Standard Sizes

The Standard Sizes for copper conductors shall be as follows:-

CONDUCTOR		
Nominal Area of Copper (mm^2)	100	150
Approximate overall diameter (mm).	12.9	16.0
Stranding No/mm	7/4.30	19/3.2
Calculated maximum d.c. resistance at 20°C (/Km)	0.1804	0.1201
Breaking load (N)	37640	58690
Approximate mass of conductor (Kg/Km)	911.2	1376

5.5.7 Tests

The conductors shall be inspected and routine tested in accordance with the requirements of BS 125.